Nanoindentation and Raman spectroscopy study of graphite irradiated with swift ^{238}U ions

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The isotropic fine-grained graphite is a promising material for future high-energy ion beam facilities [1]. Modifications of the structure and mechanical properties of R6650 graphite irradiated with 2.6 GeV ^{238}U ions at fluences up to 10^{13} ions/cm^2 at room temperature were studied using nanoindentation and Raman spectroscopy.

Indentation tests confirm that the material withstands high-fluence irradiation. Moreover, a strong ion-induced increase of Young's modulus and hardness is observed that points to a structural change and formation of a hard form of carbon. The maximum effects are observed on the irradiated surface where an ion-induced increase of hardness and modulus reaches up to 500% and 280%, respectively. A change of hardness and modulus under ion-induced stresses around the interface between the irradiated layer and the non-irradiated bulk material was observed.

Raman measurements demonstrate ion-induced disordering and reduction of dimensions of crystallite domains. After high-fluence irradiation, the Raman spectrum becomes similar to that of the glassy carbon. Despite of sp^2 bonding the structure of the glassy carbon is known to ensure a high hardness and modulus. The Raman spectroscopy revealed a similar modification of a structure also on HOPG crystals irradiated with swift ions [2].

[1] M. Winkler, H Geissel, H. Weick, et al, *Nucl. Instrum. Methods B* **266**,4183 (2008).
[2] M. Tomut, W. Ensinger, M. Krause, C. Trautmann, *GSI Scientific Report*, (2010) (in press).